AMSAT™

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AMSAT NETS

In order to keep the satellite users in touch with each other and to provide information to newcomers, the following AMSAT nets meet regularly:

North American East Coast 75 Meter Net

Mondays 9:00 p.m. EDT (0100Z Tues)

3850 kHz LSB

Net Control W3ZM, W3TMZ or K2GUG

Note the change in time and frequency

North American West Coast 75 Meter Net

Mondays 7:00 p.m. PDT (0200Z Tues)

3850 kHz LSB

Net Control W6OAL or W6EJJ

Note that East Coast and West Coast Nets are now on the same frequency, so stations in between should be able to work both.

International 20 Meter Net

Sundays 1800Z*

14,280 kHz USB

Net Control W3ZM, W3TMZ or others

International 15 Meter Net

Sundays 1900Z

21,280 kHz USB

Net Control W3ZM, W3TMZ or others

Western Europe Net

Sundays 0915Z

3780 ±10 kHz LSB

Net Control GJIOR

*GJIOR listens at 1730Z for European and African check-ins.

JA Net

Mondays 1300Z

3560 kHz LSB

Net Control JA1ANG

Southeast Asia Net

Thursdays 1300Z

14,320 kHz USB

Net Control JA1ANG or others

ZL Net

Mondays, Thursdays and Saturdays

7:00 p.m. NZT

3850 kHz LSB

Net Control ZL1WB

In addition, the frequencies 3850 kHz LSB and 14,280 kHz USB are designated as general watch frequencies for discussions of satellite matters following passes.

In the Washington area, AMSAT traffic is handled via 2 meter FM on 146.85 MHz simplex and through the AMSAT repeater WR3ABU (146.25 to 146.85 MHz).

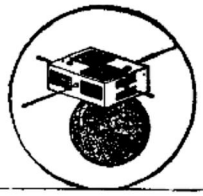
In southern California, the WR6ACJ repeater (146.25 to 146.85 MHz) has been designated as an official medium for exchanging information relating to the amateur space program. It is suggested that those in other areas also adopt 85 simplex and the 25/85 repeater combination for satellite discussions. In those areas where such repeaters already exist, check with the present inhabitants of the channel to see if they would mind having their facility used for such a constructive purpose as satellite talk. If we all standardize on this frequency combination, it will be much easier to get in touch with each other when traveling.

Readers are requested to inform AMSAT relative to corrections, additions or deletions to the above net schedules.

Bulletins of general interest to those interested in amateur satellites are broadcast regularly on OSCAR-6 reference orbits (first orbit of the Greenwich day) at approximately 10 minutes after ascending node. These bulletins are transmitted on a downlink frequency of approximately 29,490 kHz and can be received over most of eastern North America.

AMSAT-OSCAR 7 STAMP NOW AVAILABLE

A new AMSAT-OSCAR 7 rubber stamp is now available from Al Simpson, WA5TJB, 1005 East "I" Street, Russellville, Arkansas 72801, for $4.00U.S. postpaid. An AMSAT-OSCAR 6 stamp is also available, for $3.50. For shipment outside North America, please include an additional $1.00 for airmail postage. The artist's conception of OSCAR 7 was provided by Steve Hay, K5RZU and his staff at the Hesse Envelope Company in Dallas, Texas.



FROM THE PRESIDENT'S DESK

by Perry Klein, K3JTE

"Licensing Arrangements for AMSAT-OSCAR 7"

On March 15, 1974, AMSAT was issued a special license for the AMSAT-OSCAR 7 satellite, with the call letters W3OHI. Unique in that this is perhaps the first actual license issued to an amateur satellite service space station, the new license culminates six months of discussions and meetings between AMSAT and the U.S. Federal Communications Commission concerning the specific provisions governing the operation and use of OSCAR 7.

With the license the following waivers were granted for OSCAR 7 after launch and for portable or mobile operation of the spacecraft during tests before launch:

A. Section 97.43: The requirement for every amateur radio station to have one land location was waived.

B. Section 97.61: Any mode of emission authorized on uplink frequencies may be retransmitted on the downlink. (For example, teletype transmissions allowed on two meters can be retransmitted on the ten-meter downlink of the two-to-ten meter repeater, even though teletype is not ordinarily permitted at the high end of the ten-meter band.)

C. Sections 97.7 and 97.79: Any transmissions to the satellite from amateur radio stations may be retransmitted by the satellite without regard to operator frequency privileges on the satellite downlink frequencies. (This means that, as with OSCAR 6, Technician Class licensees will be permitted to use the two-to-ten meter repeater, even though their signals will be retransmitted on ten meters, a band not normally allowed to Technicians.)

D. Sections 97.117 and 97.123: Telecommand stations authorized by AMSAT may transmit coded telecommand signals to the satellite, without identifying their transmissions.

E. Section 97.87: The various requirements for identification of the satellite's transmissions were waived to the extent that only the last two letters, HI, of the call sign W3OHI need be periodically transmitted by the satellite.

While these waivers were granted by authority of the Chief of the F.C.C.'s Safety and Special Radio Services Bureau, AMSAT's request to use a 432.1 MHz uplink for the AMSAT-Deutschland repeater (instead of frequencies in the 435-438 MHz range allocated to the amateur satellite service) was referred to the F.C.C. Commissioners for action, and was approved. Unfortunately, our request to operate the 2304.1 MHz beacon was rejected by the Commissioners. The Commission ruled that they will permit AMSAT to fly the 2304.1 MHz beacon on OSCAR 7, provided we have provisions to assure that it is not turned on! We are not quite sure how successful the 2304 MHz beacon experiments are likely to beunder this restriction!

The term of the OSCAR 7 license is for five years, which represents the longest authorization yet received for an amateur satellite.

In a separate action by the F.C.C. the waivers of the same rules for the present OSCAR 6 satellite were extended for another four years, until June 22, 1978, under the authority of AMSAT's WA3NDS club station license.

It has become evident that as amateur satellites become more complex and sophisticated, so does the paperwork associated with them. While F.C.C. authorization for OSCAR 6 required a brief two-page request, authorization for OSCAR 7 required a formal application 24 pages in length, complete with a $9 application fee. Perhaps this signifies a trend toward increased "red tape" that the amateur service in the United States is encountering.

MINUTES OF THE AMATEUR SATELLITE SERVICE COUNCIL MEETING

MARCH 30, 1974 - ARLINGTON, VA

A meeting of the Amateur Satellite Service Council was called to order by Chairman Eitel at 9:10 a.m., March 30, 1974, at the Marriott Twin Bridges Motor Inn, Arlington, Virginia. In attendance were:

*William Eitel, W6UF/WA7LRU (Chairman)
*Ray Vincent, W6PUX - OSCAR
*Richard Daniels, WA4DGU - AMSAT
*Perry Klein, K3JTE - AMSAT
*Charles Compton, WØBUO - ARRL
*V. C. Clark, W4KFC - ARRL
Harry Dannals, W2TUK - ARRL
Robert Booth, W3PS - ARRL
Peter Schenk, WA4GFY - ARRL Foundation

(*Members, ASSC)

Minutes of the December 1, 1973, meeting were submitted and approved.

AMSAT REPORT: Messrs. Klein and Daniels presented information on the status of AO-6. The spacecraft continues to function well, but now requires extended battery charging time, necessitating some reduction in the time available for experimental purposes. Effective April 1, the satellite will not be available for general use during the morning orbits, although it will be activated for educational uses on Tuesday and Friday mornings. This schedule will be followed through June, at least, and will be the subject of announcements to be relayed via the satellite.

A total of 2200 users of AO-6 has been registered, with an increase of about 400 in the past three months. Czechoslovakia is the largest user per capita, with 1½% of its amateur population having communicated through AO-6. Forty percent of all users are in the United States. A total of 78 countries has been reported through AO-6 to date, and 12 amateurs have succeeded in working all states. An AO-6 Users Directory appears in the latest issue of the Call Book magazine. The possibility of ARRL handling future satellite awards was advanced, but no firm recommendations were made on this point.

The FCC license, W3OHI, has been obtained for AO-7. Work on the satellite is somewhat behind schedule but it is expected to be ready for launch in early June, should the opportunity to place it in orbit materialize then (as is tentatively expected). The launch will be from the West Coast and into an orbit similar to that followed by AO-6. Extensive administrative work has been required to fulfill NASA requirements and to document assurance of compatibility with other experiments associated with the launch. The question recently raised regarding use of the 432 MHz uplink has been the subject of extensive discussions with FCC officials, as has that of the proposed inclusion of the 2304 MHz beacon transmitter. Both matters are expected to be resolved within the next week or two.

A formal commitment by OSCAR to carry out integration functions on AO-8 has been requested by the AMSAT Board of Directors. A two-year lead time is foreseen, and OSCAR assistance is regarded as essential. Continued use of a low orbit is felt to be desirable to provide maximum usefulness for educational purposes. The desirability of incorporating a 10-15 meter satellite has been extensively discussed, but has not received the approval of the AMSAT Board of Directors. The desirability of incorporating even lower frequency experiments in future launches was noted; this would provide useful propagation information and serve as a means for attracting additional numbers of amateurs to satellite work.

OSCAR REPORT: The OSCAR report was presented by Mr. Vincent. OSCAR's President for 1974 is Chuck Towns, K6LFH. Mr. Towns has been active in the Sister Cities program and is working with ARRL and Town Affiliation Association people.

Equipment donations have been arranged to one "sister city." An international conference of the TAA is to be held in Phoenix, Arizona in September, and ARRL President Dannals has been invited to speak. The Sister Cities activity is not regarded by OSCAR as an appropriate continuing activity for that group, however, and sponsorship may soon be transferred to another group. The spaceframe for AO-8 is proceeding and is expected to be ready for AO-8. Work is conducted on an all-volunteer basis. OSCAR expects to be able to pick up on integration activities following completion of the AO-8 spaceframe. OSCAR continues to acquire space-grade components and materials for future amateur satellite use, and continues to furnish materials and components to AMSAT and to AMSAT-Deutschland.

ARRL REPORT: This was prepared by Messrs. Dunkerley and Waters, and presented by Mr. Clark.

NASA has requested that ARRL provide (a) an amateur satellite exhibit for the main hall and (b) a demonstration unit for the lecture hall at the Visitor Center at Kennedy Space Center, one of the two largest NASA centers in terms of tourist traffic - the other is at Houston. Kennedy has about four million visitors per year from all over. Preliminary drawings of the proposed ARRL exhibit unit have been prepared and copies provided to ASSC members; approximate cost of this undertaking will be $6000. The objective will be to present the excitement of amateur radio via the OSCAR satellites and their classroom applications.

Channel 24, Connecticut's public television station, has produced at ARRL instigation, a half-hour documentary on the classroom uses of OSCAR featuring Jean Shepherd, K2ORS, as host/MC, filmed at Talcott Mountain. This will be aired sometime within the next few weeks. The purpose will be to introduce it into the public television network nationally and to offer videotapes to those metropolitan schools having such facilities.

A newsletter has been distributed to NASA's mailing list of 35,000 science teachers. Replies are already beginning to come in. The teacher response to the various ARRL mailings and especially to the curriculum supplement has been almost unanimously enthusiastic.

The Talcott Mountain Science Center has submitted to the ARRL Foundation a proposal for funding a new staff position to provide coordination, guidance and expertise to educators in classroom uses of OSCAR on a continuing basis, beginning with a pilot project.

The goal in this program is primarily to present amateur radio to the public in a favorable, glamorous light, using the OSCAR satellites as a vehicle. NASA adds prestige and the educational channel is excellent for exposure efficiently and economically.

Construction of control circuitry for the Talcott Mountain remote OSCAR command system is now complete and being tested. Next step will be to test the system between the headquarters building and W1AW. Following this, the transmitting equipment will be returned to Talcott Mountain and the encoder retained at W1AW for remote commanding.

ARRL FOUNDATION REPORT: Mr. Peter Schenk, Vice President of the ARRL Foundation, provided a capsule report of progress at the initial meeting of the Foundation's Board of Directors. The AMSAT request for 1974 funding in the amount of $13,500 was approved in principle, subject to the availability of funds. It is considered to be the first project in line for funding from non-earmarked funds. A request for funds by the Talcott Mountain Science Center was referred to the Board's Executive Committee for further study. Mr. Schenk is Chairman of the Foundation fund raising committee.

SPLITTING OF SATELLITE BAND BETWEEN CW AND PHONE: Separation of voice and cw activity has been proposed by some AO-6 users. This matter was the subject of an extended discussion although no positive conclusion was reached. The question was then tabled and will be the subject of further consideration at the next meeting of the ASSC.

DOCKET 19852: ARRL General Counsel Booth has filed a request for extension until July 8, 1974, of the time allowed by FCC for comments on this Notice of Inquiry. A section-by-section review of the proposal followed, resulting in general concurrence in the draft comments prepared by OSCAR. Although AMSAT, OSCAR and ARRL will file separate comments on Docket 19852, the membership of ASSC unanimously endorsed the extension of time being requested by ARRL.

ARRL OFFER OF ADMINISTRATIVE ASSISTANCE TO AMSAT: Chairman Eitel pointed out the desirability of relieving AMSAT personnel of all possible administrative workload so as to free them to maximize their technical contribution to the amateur satellite program. ARRL President Dannals concurred in this and pointed out the extent of time and financial support now being given by ARRL to the satellite program, particularly in the educational area. This may require future funding assistance by the ARRL Foundation, although it would be only after needs of the technical aspects of the program had been met. Administrative costs would not involve use of matching funds offered by Messrs. Eitel and Hoover to the Foundation for the satellite program.

The meeting was adjourned at 4:00 p.m.

Respectfully submitted,
V. C. Clark, W4KFC

AMATEUR SATELLITE MATCHING FUNDS

William Eitel, WA7LRU/W6UF, and Herbert Hoover III, W6APW, have generously offered to match, dollar-for-dollar up to a total of $25,000, donations to the ARRL Foundation earmarked for use in the amateur satellite program.

Funds are urgently needed to support the construction of AMSAT-OSCAR 8, which is estimated will cost on the order of $100,000.

We urge you to support the amateur satellite program with a financial contribution. Please return the form below with your donation to the ARRL Foundation right away, while matching funds are still available. Contributions to the ARRL Foundation are tax-deductible under Section 170 of the Internal Revenue Code.

Thank you for your support.

TO: The ARRL Foundation, Inc.
225 Main Street
Newington, Connecticut 06111

Date: _____

Gentlemen:

Enclosed is my contribution of _____ which I wish to designate for AMSAT's amateur satellite program, as part of the Eitel-Hoover matching fund offer.

Name: _____ Call: _____

Address: _____

_____

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D. C. 20554

In the Matter of	)	
	)	
Inquiry into provisions	)	DOCKET NO. 19852
for the Amateur-satellite Service	)	
in Part 97 of the Rules.	)	

To: The Commission

COMMENTS OF

RADIO AMATEUR SATELLITE CORPORATION (AMSAT)

The Radio Amateur Satellite Corporation (AMSAT) respectfully submits the following comments in response to the Commissions's Notice of Inquiry, released October 30, 1973 (FCC 73-1097), relating to provisions for the Amateur-satellite Service in Part 97 of the Rules.

Background

AMSAT is a non-profit, tax-exempt 501(c)(3) scientific corporation founded in the greater Washington, D.C. area five years ago. AMSAT's purposes and objectives as set forth in its Bylaws are:

A. To provide satellites that can be used for amateur radio communication and experimentation by suitably equipped amateur radio stations throughout the world on a non-discriminatory basis.

B. To encourage development of skills and the advancement of specialized knowledge in the art and practice of amateur radio communications and space science.

C. To foster international goodwill and cooperation through joint experimentation and study, and through the wide participation in these activities on a noncommercial basis by radio amateurs of the world.

D. To facilitate communications by means of amateur satellites in times of emergency.

E. To encourage the more effective and expanded use of the higher frequency amateur bands. And,

F. To disseminate scientific, technical and operational information derived from such communications and experimentation, and to encourage publication of such information in treatises, theses, trade publications, technical journals or other public media.

Since its creation in 1969, AMSAT has been responsible for three satellite projects:

1. Australis-OSCAR 5 - A satellite built by students at Melbourne University in Australia. Licensed to AMSAT by the Commission on June 10, 1969, and launched by NASA in January 1970, AMSAT completed extensive modifications, testing, launching arrangements and data collection for this satellite project.

2. AMSAT-OSCAR 6 - First of a series of long-lifetime amateur satellites, OSCAR 6 continues to serve for regular use by approximately 2,200 amateurs in over 78 countries since its launch by NASA in October 1972. It was licensed by the Commission to AMSAT under the authority of the WA3NDS license, and AMSAT was responsible for the spacecraft design, fabrication, testing, launch arrangements, telecommand and operation.

3. AMSAT OSCAR-B (OSCAR 7) - This amateur communications satellite is now in final testing for a launch by NASA this summer. Expected to operate for three years or more, OSCAR 7's subsystems have been developed by amateur groups in the United States, Australia, Canada, and West Germany under AMSAT's management. The Commission issued the license W3OHI to AMSAT for this satellite on March 15, 1974, for a five-year term.

Considering the experience of AMSAT with these three projects, and AMSAT's past and continuing role in the development of the Amateur-satellite Service, our organization, representing a membership which numbers over 1,240 members and member societies, should be well qualified to comment in this proceeding.

Philosophy of Rules for the Amateur-satellite Service

Over the past twelve years since the launch of the first OSCAR (Orbiting Satellite Carrying Amateur Radio), each satellite has operated under certain waivers of the Amateur Rules granted by the Commission on an individual, case-by-case basis. This has been feasible because of the small number of satellites involved and because each satellite has been unique in its design and operation. Also, there have been only two organizations applying for licenses for these satellites, namely Project OSCAR, Inc. (licensee of the first four OSCAR satellites) and AMSAT (licensee of OSCARs 5, 6 and 7). The 1971 ITU World Administrative Radio Conference for Space Telecommunications formally recognized a new Amateur-satellite Service and began to establish definitions. However, if the Amateur-satellite Service is to develop technologically and operationally to its fullest, it will best do so with enabling rather than restrictive regulation. With this in mind, AMSAT offers specific suggestions in response to the Commission's Notice of Inquiry intended to establish a reasonable balance between necessary operational discipline, and flexibility for constructive experimentation and innovation.

Specific Suggestions for Definitions

To a large extent, any new and separate rules covering earth stations and telecommand stations can be minimized through the establishment by the Commission of broader definitions in Section 97.3 of the Rules. Specifically,

Redefine: 97.3(e) Amateur radio station - A station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communication *or for communication through or with a space station operating in the Amateur-satellite Service.*

Reason: The above definition permits all appropriately licensed amateur radio stations to participate in satellite operation without requiring the issuance of special licenses to satellite users. In this way, maximum participation can be realized, and the responsibility for operating within the already established Amateur Rules is clearly placed on the user stations. This is practical because the techniques used by amateur radio stations communicating via OSCAR satellites are similar to the techniques used for regular terrestrial amateur communications.

Define: Amateur-satellite telecommand station - An amateur radio station making transmissions to an amateur space station for the purpose of controlling the operation of that amateur space station.

Reason: This definition permits any authorized amateur radio station to function as an amateur-satellite telecommand station without requiring a special license. The issuance of a special license to each such station is unnecessary because the telecommand functions are performed by regular amateur operators, and it is very important that the telecommand stations be appointed by the space station licensee and remain under this licensee's direct authority and control. The suggested definition is also intended to be distinguished from *control stations*, for which other Amateur Rules are meant to apply.

A space radio station is already defined in Section 97.3(j) of the Rules as "an amateur radio station located on an object which is beyond, is intended to go beyond, or has been beyond the major portion of the Earth's atmosphere." This basic definition was established at the 1971 World Administrative Radio Conference.

Specific Suggestions for Rules to Eliminate the Need for Waivers

In the past licensing of OSCARs 1 - 7, certain waivers of the Rules were necessary for the satellites, the user stations and the telecommand stations, basically because certain rules intended for terrestrial operation were not suitable when operating with space stations. The addition of several enabling rules will remove the need for the most common waivers likely to be required in the future. Suggested additions are given below.

Section 97.43 Location of station. Add to this section: "The provisions of this Section are not applicable to amateur space stations." Alternatively, it would be possible to specify that in the case of amateur space stations, the planned orbital parameters should be furnished the Commission before launch, and the actual values after launch.

Reason: The requirement that "every amateur station must have one land location, the address of which is designated on the station license" is not appropriate or applicable to a space station. Instead, space station locations may be determined by the orbital parameters and ephemeris.

Section 97.61 Authorized frequencies and emissions. Add a Section 97.61(d): In the case of amateur space stations, any mode of emission authorized on uplink (space station receiving) frequencies may be retransmitted by the space station, provided that the uplink frequencies are within the amateur bands authorized in Section 97.61(a).

Reason: The above new section will permit a broad interpretation of the Rules to encourage experimentation with teletype, facsimile, ranging, medium-scan television and radio-control using space stations, as well as new modes not yet developed.

Sections 97.9 and 97.79 Privileges of operator licenses and Control operator requirements. Add a Section (e): In the case of amateur space stations, any transmissions to the space station from amateur radio stations may be retransmitted by the space station without regard to operator frequency privileges on the space station transmitting frequencies.

Reason: Amateur space stations generally use different uplink (receiving) and downlink (transmitting) bands to permit the users to monitor their own signals as they are retransmitted by the satellite. The proposed section recognizes this fact and removes any difficulties that may result from different allocations for different classes of users on the separate bands. We have suggested that the language used in the OSCAR 7 license issued to AMSAT be incorporated in Sections 97.9 and 97.79 to recognize this situation. It is important to emphasize that this regulation is not designed to extend the operating privileges of any group of licensees, but rather is required for technical and international frequency coordination reasons. These considerations are important because of the limited number of bands presently allocated to the Amateur-satellite Service, some of which are not available to Technician Class licensees.

Section 97.87 Station identification. Add a new Section 97.87(i): "In the case of an amateur space station, that station shall be identified by specifying the angle of inclination of the orbit, the period of the object in space and the altitudes of apogee and perigee of the space station in kilometers. In the case of a space station on board a stationary satellite, the mean geographical longitude of the projection of the satellite's position on the surface of the Earth shall be specified."

Reason: The principal means of identifying an amateur space station is its unique and precisely established position in space at any point in time. Orbital elements are accurately determined soon after launch and updated periodically thereafter. Relatively simple predictive techniques are available to permit use of these data to locate the satellite at any time. For the next several years, no more than one, or at the most, two amateur satellites are likely to be in operation at the same time. In a practical sense, therefore, station identification will not be a problem. Signals transmitted or retransmitted by a space station are uniquely identified by their propagation and modulation characteristics. These generally include a pronounced Doppler shift in frequency, and tones or codes unique to any telemetry beacons in use. Telemetry systems now in the planning stage are designed to operate with microprocessors and other sophisticated minicomputer decoding equipment. It is impractical to design such systems to identify in clear code in such a manner that stations other than those equipped for these specialized transmissions can decode them.

Section 97.117 Codes and ciphers prohibited. Add a statement that: In the case of amateur-satellite telecommand stations, coded telecommand signals may be transmitted to a space station to preclude duplication by unauthorized persons.

Reason: The nature of the telecommand systems used in amateur satellites requires the transmission of coded signals to provide the command function, and at the same time, security against unauthorized access.

Section 97.123 Unidentified communications. Add a statement that: In the case of amateur-satellite telecommand stations, coded telecommand signals may be transmitted to a space station without identification.

Reason: The security of telecommand systems against unauthorized access requires that knowledge of the telecommand frequencies be kept from public knowledge. It is therefore important that amateur-satellite telecommand stations not be required to identify their transmissions.

Comments on Requirements for Space Station Licenses

AMSAT-OSCAR 7 is the first amateur satellite to be formally licensed as a space station in the Amateur-satellite Service. The previous six OSCAR satellites were all licensed under the authority of regular club station licenses (W6EE and WA3NDS) by letters authorizing their operation rather than by issuance of special licenses. Considering the representations made in applying for authorization for AMSAT-OSCAR 7 and past satellites, it is reasonable to expect that future applications for amateur space station licenses would include the following representations:

A) An application filed on F.C.C. Form 610-B (in the case of a club), or on Form 610 (if filed by an individual).

B) The expected orbital parameters before launch, including:

i) Planned launch date, launch location and launch agency.

ii) Expected lifetime.

iii) Angle of inclination of the orbit.

iv) Period of the orbit.

v) Altitude of apogee, in kilometers.

vi) Altitude of perigee, in kilometers.

vii) In the case of a synchronous satellite, the mean geographical longitude of the projection of the satellite's position on the surface of the Earth.

C) Operating frequencies, bandwidths, and power levels.

D) A description of the telecommand system, including a list of command functions and a list of amateur-satellite telecommand stations equipped to control the satellite's emissions.

E) A description of the means of identification.

F) A description of waivers to Amateur and/or Amateur-satellite Rules requested, with reasons.

Conclusion

It is important that if the Amateur-satellite Service is to develop in the future, any regulations should be enabling rather than restrictive. This is particularly true since it is impossible to predict what forms satellites and satellite experiments are likely to take in the years to come. Through a judicious choice of broad definitions in Section 97.3 of the Amateur Rules, the need for special licenses for earth stations and amateur-satellite telecommand stations can be obviated. In addition, minimal rules are needed to eliminate the requirement for waivers that have been granted each time in the past. All of these rules can be incorporated into Part 97 of the Amateur Regulations without involving the addition of a new subpart.

In summary, AMSAT urges the Commission to avoid any regulation that might limit the growth of the Amateur-satellite Service. It is our view that satellites represent the cutting edge of technology in the Amateur Radio Service and are a vital key to its future growth and development.

Respectfully submitted,

P. O. Box 27
Washington, D.C. 20044

RADIO AMATEUR SATELLITE
CORPORATION (AMSAT)

April 8, 1974

By Perry I. Klein

Dr. Perry I. Klein
President

AMSAT MEETING NOTICE

There will be a general meeting of AMSAT at 8:00 P.M. Saturday June 15, 1974, at Goddard Space Flight Center, Greenbelt, Maryland. The principal subject of the meeting will be OSCAR-7 including its design, launch schedule and operation. It is anticipated that the OSCAR-7 spacecraft or parts of it will be on display. This is, of course, subject to the pre-launch ground test schedule.

This meeting should not be confused with the annual meeting which will be held sometime next fall.

Keep tuned to the AMSAT nets (see page 2) and to the reference orbit bulletins for further details.

GETTING ON OSCAR 7: 432 MHz EQUIPMENT SUGGESTIONS, AND BIBLIOGRAPHY

by Joe Reymann, W6PAJ

The imminent launch of AMSAT-OSCAR-B (to be known as AMSAT-OSCAR 7 once in orbit), with its 432 to 144 MHz translator, has created a surge of interest in transmitting equipment for the 432 MHz band. For those who prefer not to design from scratch, or who lack the time to do it right, this article will serve as a reference source for enough equipment of various types to be able to assemble a 432 MHz transmit capability.

CW TRANSMITTERS

Keep in mind that the preferred modes on OSCAR 7, as on OSCAR 6, are cw and ssb. The lower duty cycle of these modes provides more efficient utilization of the limited spacecraft rf power than does fm, am, rtty (fsk or afsk), and sstv although all such modes have been used through OSCAR 6. CW will probably be the most popular (at least in terms of number of users!). There are two inexpensive and "easy" methods of generating stable 432 MHz cw power: modification of commercial 450 MHz equipment, and building or buying a varactor-tripler from 144 MHz.

Readily available on the commercial surplus market are several varieties of 450 MHz fm transmitter strips, at $10 and up. The author has had experience with the Motorola units (from T44, J44, etc. stations), which put out about 15-18 watts at 450 MHz. Follow the simple conversion instructions in the popular FM Schematic Digest for Motorola units, and then disable the modulator and provide a method for keying as in the September, 1971 QST article. Schematic information is also available for GE units. Almost every area of sizable ham population has someone up on the latest availability and conversion of commercial gear. A few minutes with him will answer many questions. Some commercial power amplifiers are also available; see that section below.

The varactor-multiplier has a lot going for it. It is relatively easy to build and needs no power supply. Its overall efficiency is decent. Operating at medium power levels (20-40 watts input), it does generate some strong 'auxiliary' signals which need to be suppressed. However, considering the cost and speed of construction, it will be a favorite for hams new to 432. Several circuits have been described in ham literature, both doublers and triplers. The tripler circuits should be more popular since 144 MHz transmitters are more numerous than 216 MHz ones. Commercially-built units are also available.

SSB

A single-sideband (or all-mode) transmitter can be made relatively inexpensively. Anyone with 28, 50, or 144 MHz cw-ssb equipment can generate 432 cw/ssb with any of several transverters described. The author has one of the neat little 28-432 MHz units described in VHF Communications. It is solid-state, works on 12 v.d.c., and works at low signal levels. This last is a matter of choice, but the author prefers to generate a low-level signal on frequency and follow that with linear signal amplification. Generating high-level signals has an apparent advantage of needing fewer stages, but the unwanted products are harder to filter out. Anyway, the VHF Communications unit costs less that $35 for the basic components kit and is available through Bob Eide at the address shown. It puts out 150-250 mw depending on "B+" voltage on the final transistor amplifier. Plan on needing a power amplifier, but the disadvantages of this are outweighed by the opportunity of being in the technical forefront with a 432 MHz ssb signal.

There are transverter circuits operating from 10, 6, and 2 meters. At least one unit is available commercially-made, in addition to the VHF Communications unit just mentioned. Braun in West Germany, which used to have representation in the U.S., has a unit advertised in foreign vhf publications. The transverter in general is more complex to build than the varactor-multiplier, but has the advantage that it is not mode-limited. The transverter, operating on the heterodyne principle rather than on multiplication, can be used on any mode the exciter can generate. It is therefore the better long-term solution to getting on 432.

POWER AMPLIFIERS

AMSAT estimates that 300-400 watts erp (Effective Radiated Power = rf power delivered to the antenna multiplied by antenna gain) will be needed to work through the 432-144 MHz translator. KEEP IN MIND THE FCC 97.61(b)(7) LIMITATIONS ON 432-band POWER! Waivers of this limitation can be granted on individual application. I imagine that the AMSAT nets will have more information on this as launch time approaches.

Most users will therefore want to consider a power amplifier. Remember that the best and cheapest power amplifier will probably be a better antenna, but more on that later.

A good starting point for 432 power amplifiers is the June 1971 article from Ham Radio magazine. From there the bibliography lists several circuits of varying complexity and outputs. For those not familiar with vhf circuit construction, the best advice is: do your homework in the VHF Manuals, select one of the less complex circuits, and proceed with care. Nothing is particularly difficult, but vhf construction practices are somewhat different.

A neat solid-state three-stage amplifier has just been described in the Spring 1974 issue of VHF Communications magazine. Operating on 12 v.d.c., it is a natural companion for the transistorized transverter mentioned above.

A great source for power amplifiers is the Motorola T44 (or J44, etc.) unit mentioned earlier. The largest part (for me) of a 432 power amplifier is the plumbing or metal work. Commercial 450 MHz fm units have that already done for you. A major benefit of the Motorola T-110 or TU-204 series transmitters (used in the -44 series) is the ease of removal. Take out twelve screws, clip half a dozen or so wires, and you have a ready-to-tune two-stage 2C39 amplifier (actually a 150-to-450 MHz tripler and a 450 MHz power amplifier). Both tune down to the 432 MHz region. Together with the VHF Communications solid-state upconverter from 10 meters, you'll have a pretty easy job of generating 432 ssb at a reasonable power level (10-40 watts depending on power supply voltages). With a decent antenna and little line loss, that should be enough to get you through OSCAR 7. Or, this setup makes a great exciter for a higher-power amplifier. By the way, if you do get your 2C39 power amplifier this way, save the rest of the chassis. It is a complete two-meter fm transmitter ending in a 2E26 (TU-110) or 6146 (TU-204), with little or no conversion needed.

Motorola and others make several pieces of 450 MHz commercial band equipment which operate at power output levels of 50-250 watts. While conversion information is not as readily available on a step-by-step basis, the circuits are not nearly as complex as the exciter circuitry, so conversion should be much easier. Many will tune to 432 MHz as is. A limiting factor for many will be availability of schematic diagrams, but most power amplifier conversions don't really require access to schematics. Remember the local help available in many places from the ham-fm fraternity, or local hams involved in servicing commercial equipment.

ANTENNAS

As we said earlier, a good antenna is probably the cheapest way of obtaining gain. Let's digress just a bit to amplify our earlier statements on erp, for those not familiar with its application in ham circles. Your effective radiated power is the power input of your transmitter with losses considered: amplifier efficiency (100 watts input might give 65 watts output) and tank losses, loss in the coax cable (your transmission line might eat up 75% of your 432 energy!), multiplied by antenna gain. Antenna gain must be a pure number, not in dB. A 10 dB gain just happens to be a real gain of 10 times, but other dB numbers require some interpretation. A gain of 13 dB is a multiplier of 20, a gain of 6 dB is a multiplier of 4, and so on.

Several manufacturers make antennas covering the 432 MHz band. Of these, the CushCraft is one of the easiest to work with, in my opinion. CushCraft on occasion makes, but does not advertise, a twenty-element crossed-Yagi for 432 MHz. Equipped with gamma matches and set up for rear mounting, this antenna is easy to tune and mount on a straight rotator or an azimuth-elevation mount. It comes complete with pre-cut phasing lines for circular polarization, and it can of course be used with the vertical or horizontal feed separately for linear polarization.

Antennas for the 432 MHz band are very easy and inexpensive to make. A few hours with hand drill, hacksaw, and file will result in an 11-element beam described in the ARRL VHF Manual (2nd edition). With a little extra effort, a nice crossed-Yagi can be made by doing everything twice. Materials necessary: One piece of 1" by 1" lumber, a few aluminum or brass welding or brazing rods, a U-bolt for mounting, and coax connector and coax for the feed.

In choosing your antenna, remember that a power gain of 10 dB is easier and faster to obtain by switching from an omni-directional antenna to a Yagi. Even a gain of 13-16 dB is obtained at 432 MHz in a very small antenna. Of course, you also "gain" the necessity of tracking the satellite by antenna rotation every few minutes, which is unnecessary with an omni-directional antenna. But, even vertical omni-directionals have a cone of silence upward from the end, resulting in some periods of unusability on near-overhead passes.

For antenna tune-up, build a cheap but effective reflected power meter. I have built both the one in the ARRL VHF Manual (2nd edition) and the one from Ham Radio magazine. Both are easy and effective, but the HR unit is a breeze to assemble from the kit and is almost foolproof.

AZIMUTH-ELEVATION MOUNTS

Choosing a directional antenna implies that you are going to rotate it to point in the general direction of the satellite. The ordinary rotator is designed to point the antenna in azimuth, or horizontal direction. That approach is usable for satellite work, but the more gain your antenna has, the narrower is its pattern. While most amateur antenna systems will have a pattern of at least 45°, this is narrow enough to limit your signal into the satellite on orbits whose track is closer than 500 miles from your location. It helps to mount your beam on the rotator so that it points about 15-20 degrees above the horizon. This will reduce your unworkable area to a relatively small part of the orbits very near the local vertical. However, the purist complains of any compromise, and most of us have to use any antenna for many uses; who can afford to make a special purpose antenna just for satellites? So, it helps to be able to point the antenna in elevation as well as in azimuth. The resulting radar-like antenna system might seem like something out of the movie "2001" to your neighbors, but it is easy to build and operate, and the cost can be kept low. The author's installation was made from two TV rotators, and crossed-Yagi antennas on 144 and 432 MHz. Some have even added a lightweight 10-meter beam (QST, May 1973, p. 62).

Whatever rotators you choose, pick ones with set-and-forget controls rather than the hold-down-the-bar type. Watching an azimuth or elevation indicator is not for the satellite tracker. I use two Alliance rotators: a C-225 for azimuth and a U-100 for elevation. The less expensive U-100 can be used for both functions. Make sure you pick an elevation rotator of the type where the boom goes entirely through the rotor.

BIBLIOGRAPHY

In the bibliography which follows, some units are described in several different places: for example, in the Handbook and the VHF Manual. The plurality of references is given to facilitate location by hams who might not have access to a particular publication.

BIBLIOGRAPHY ON 432 MHz EQUIPMENT

Amplifiers:

FM and Repeaters (ARRL), p. 69
Ham Radio Magazine, Sept. 1968, p. 6
Ham Radio Magazine, Apr. 1970, p. 40
Ham Radio Magazine, June 1971, p. 6
QST, April 1972, p. 49 and May 1972, p. 59
QST, Oct. 1972, p. 31
Radio Amateurs Handbook (ARRL), 1970 or 1971, p. 453
Radio Amateurs Handbook (ARRL), 1973 or 1974, p. 226, 232
RSGB VHF-UHF Manual, p. 6.50, 6.54, 6.56, 6.58 (Available from Comtec Books, Greenville, New Hampshire 03048)
VHF Communications Magazine, Nov. 1970, p. 236
VHF Communications Magazine, Aug. 1972, p. 144
VHF Communications Magazine, Spring 1974, p. 30

Antennas:

QST, Jan. 1972, p. 96 and Mar. 1972, p. 101
QST, Jan. 1973, p. 21
Radio Amateurs VHF Manual (ARRL), 2nd Ed., p. 220
Radio Amateurs VHF Manual (ARRL), 3rd Ed., p. 211

Azimuth-Elevation Mounts:

CQ, Dec. 1970, p. 42
QST, May 1973, p. 62
QST, June 1973, p. 11

Catalogs:

Alliance Manufacturing Company, Alliance, Ohio (rotors)
CushCraft, 621 Hayward St., Manchester, New Hampshire 03103 (antennas)
Carmichael Communications, P.O. Box 256, Carmichael, Calif. 95608 (transverters)
J-Beam antennas, c/o VHF Communications Magazine
Karl Braun, Bauvereinstrasse 40, 8500 Nurnberg, West Germany (varactor triplers and transverters)
Spectrum International, Box 1084, Concord, Mass. 01742 (Multipliers)
VHF Communications Magazine, 53 St. Andrew, Rapid City, S. Dakota 57701 or 915 N. Main St., Jamestown, N.Y. 14701 (kits, antennas and magazine)

Commercial Surplus:

FM Schematic Digest (Motorola units), $6.50 to S. Wolf, P. O. Box 535, Lexington, Mass. 02173 (see description QST, Jan. 1971)
QST, Sept. 1971, p. 39
QST, Dec. 1972, p. 28 and Feb. 1973, p. 36

Test Equipment:

Ham Radio Magazine, Dec. 1972, p. 22
QST, Apr. 1972, p. 21
Radio Amateurs VHF Manual (ARRL), 2nd Ed., p. 282
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Radio Amateurs Handbook (ARRL), 1973 or 1974, p. 636

Transmitters:

RSGB VHF-UHF Manual, p. 6.79.

Transverters:

Ham Radio Magazine, Jan. 1970, p. 48 and June 1970, p. 79
Ham Radio Magazine, June 1971, p. 6
QST, Nov. 1973, p. 47 and March 1974, p. 83
Radio Amateurs VHF Manual (ARRL), 2nd Ed., p. 246
Radio Amateurs VHF Manual (ARRL), 3rd Ed., p. 290
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FM and Repeaters (ARRL), p. 68
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Radio Amateurs Handbook (ARRL), 1970, p. 444 or 1971, p. 443
Radio Amateurs Handbook (ARRL), 1973 or 1974, p. 217
Radio Amateurs VHF Manual (ARRL), 2nd Ed., p. 243
Radio Amateurs VHF Manual (ARRL), 3rd Ed., p. 288, 289
RSGB VHF-UHF Manual, p. 6.16

TEN AMERICAN DISTRICTS AWARD

The Lockheed Amateur Radio Club, sponsors of the Ten American Districts Award, will now issue specially endorsed certificates to show OSCAR 6 or OSCAR 7 operation. To qualify for the special endorsement, all QSL cards must show two-way QSO via the appropriate satellite. In addition, regular award rules are as follows:

1. The award is available to all licensed amateurs and ham club stations.

2. QSL cards must be submitted as proof of two-way contacts with each of the ten USA amateur radio call districts (1 thru Ø). KH6 counts as the sixth district, KL7 as the 7th district.

3. Each QSL must show a postmark or QSL bureau marking, or must be accompanied by the original envelope in which it was mailed. There is no minimum report requirement, but a report is required on the card.

4. All contacts must have been made from the same call area, but not necessarily from the same location.

5. Mobile, portable, or fixed-portable contacts are OK, as are cross-mode contacts.

6. No specific QSO dates are required.

7. If your callsign changes, previous contacts do count as long as you made them from the same call area.

8. Application must be accompanied by $1 or appropriate IRCs to pay award costs and return postage for award and QSLs.

9. Send QSL cards and $1 to Lockheed Amateur Radio Club, 2814 Empire Avenue, Burbank, California 91504. Award manager is Bill Welsh, W6DDB.

This endorsed certificate is an excellent U.S. counterpart to the WVE Satellite Award, as well as a good stepping-stone on the way to WAS. The first two OSCAR 6 endorsements were issued to K2QBW and K2QBW/3.

A 432/435 MHz CONVERTER FOR OSCAR 7
(PRINTED CIRCUIT)

by Ron Dunbar, WB9NLF/WØMJS

With OSCAR 7's launch date rapidly approaching, many amateurs have expressed an interest in developing receiving capabilities for the 435.1 MHz beacon which will be aboard. In the past converters for this band have presented construction difficulties for those who have had limited experience in building VHF/UHF equipment. Repeatable results are sometimes difficult to realize due to differences in lead length, component placement, shielding requirements, etc. Printed circuit techniques greatly enhance the inexperienced builder's chances of obtaining satisfactory results by automatically forcing proper component layout and bypassing.

Unfortunately, there has been a great scarcity of 432 MHz converter designs utilizing printed circuitry, however, an excellent design recently appeared in an article by DCØDA in the August 1973 issue of VHF Communications. The circuit presented here is a modified version of that design, with the oscillator/multiplier chain added to the same 4"x6" double-sided glass PC board.

The converter demonstrates excellent UHF selectivity by using air spaced stripline techniques and bandpass coupling. As a result, the converter is remarkably free of the usual birdies caused by interference and cross modulation products from strong signals located near the 432 MHz amateur band. Several of these converters have been constructed by different amateurs to ensure repeatability of performance. Measurements by AMSAT show the noise figure of 4.0 dB and the gain of 28 dB to be easily obtainable.

Although the schematic indicates circuit values for 432 MHz input and 28 MHz output, 435/28 MHz operation may be had by substituting a 67.833 or 101.750 MHz crystal at Y1, and retuning the appropriate circuits.

To ensure stable operation, use only top quality capacitors for bypassing and coupling. Excellent results were obtained with both dipped mica and microwave type flat capacitors used in the circuit. Do not overlook the 3 ferrite beads which are slipped over the base end of the 4.7K resistors in each RF stage. They were found necessary to eliminate a random oscillation which occurred outside the bandpass, and which was only detectable on a spectrum analyzer. These oscillations will seriously degrade the noise figure of the converter.

CONSTRUCTION:

All components and shields are mounted on the ground plane side of the board. The BNC connectors should be mounted facing out from the opposite side. Mount all resistors and RF chokes in the RF and mixer stages at least 2 mm above the surface of the board to lessen capacitance to the ground plane. Double check to see that both sides of the board are soldered on the grounded end of all components, especially the variable capacitors, or instability will surely result.

Run a shield (made from thin double-sided PC material) the entire length of the board to separate the oscillator section, and place the remaining three shields to separate the RF and mixer sections as shown on the schematic.

Ensure that the metal can 2N918's don't touch any other component leads, since most manufacturers connect the collector to the can.

A 4"x6"x1½" BUD AC-431 chassis box may be used as a housing by filing a small portion of the lip to clear the input connector's mounting nut. Use care to ensure no shorts exist when mounting the board to the box.

TUNEUP:

Tuneup of the oscillator/multiplier chain is simplified by the use of the simple, but very sensitive RF indicator shown below:

The meter, diode, and capacitor may be mounted in a small plastic box, with binding posts for attaching various pickup devices. For most purposes, a ½" diameter 2 turn loop of #20 hookup wire extended about 4" from the box serves the purpose well.

Couple the indicator lightly to L9 and adjust for maximum output and reliable starting of the oscillator. This oscillator has proven extremely stable, and oscillates vigorously with practically any crystal. (It is suggested that you construct a duplicate of this oscillator on a scrap of PC material, using the same component values except: 11t for L9, and a 43.5 MHz crystal for Y1. This will give you an excellent signal source on 435 MHz for tuning up the RF section in the converter.)

Next, adjust Q5's output circuit for maximum. Verify the output frequency of Q4 and Q5 with a grid dipper. (For 435/28 MHz operation, Q4's output is either 67.833 or 101.75 MHz, and Q5's output is at 203.5 MHz.) Couple the RF indicator closely to the center of L7 and adjust for maximum indication. You will not see much of an indication of 407 MHz energy here and may have to temporarily increase the injection by substituting a 47 pf capacitor for C1. This will cause some detuning of L7 and L10, but will give you enough signal to get you into the right ball park.

Now peak L8 for maximum noise at 28 MHz, and verify with a signal from the grid dipper.

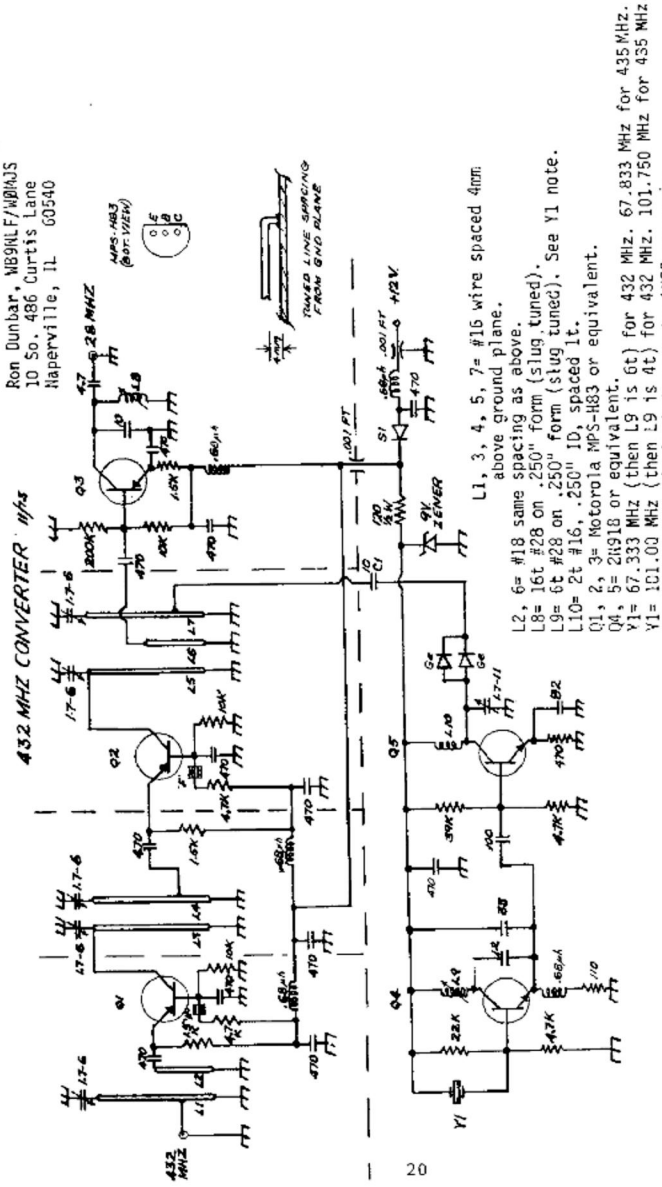
Tuning of the RF stages can be a little tedious because the very selective tuned circuits may be so far off resonance initially that it takes a hefty signal to hear anything. To simplify the 'hunt and tweak' method, attach a small clip lead to the center of L5 to act as an antenna, and peak L7 for maximum signal from the 435 MHz signal source. (All tuned lines are at ground potential, so you can't hurt anything when attaching the clip lead.) Now move the clip lead antenna to the center of L4, and peak L5. Move lead to L3, and peak L4. Move the lead to the input connector and peak L1.

Now that you can easily hear the 435 MHz signal source, it is recommended that the tuned circuits be broad-banded; i.e., peak L1 at the center frequency, L3 300 kHz low, L4 300 kHz high, and L5 at the center frequency, for instance. This adjustment procedure enhances both noise figure and stability. Further improvements in NF may be realized by adjusting the tap points on L1, L4 and L7. The value of C1 seems to provide the optimum value of injection, but may be adjusted up or down to provide more or less injection, as your particular system needs dictate.

All the components used in this converter are readily available at reasonable prices. Johnson type 'U' variable capacitors (189-503-5) are listed at 64¢ (for use in the RF stages), and (189-504-5) for the Q5 tuned circuit sells for 66¢. They were found in stock at Newark Electronics. Motorola MPS-H83 transistors are now $1.15 each. The ferrite beads are available from Amidon at a nominal cost per package. Any good VHF NPN can be used at Q4 and Q5, provided the Ft is 500 MHz or so. Try any garden variety germanium diodes you may have on hand for the two multiplier diodes; several unmarked varieties worked well for me.

Shown below is a schematic of the 432/435 MHz converter. For a full-size printed circuit layout, send a self-addressed, stamped envelope to the author, Ron Dunbar, WB9NLF/WØMJS, 10 So. 486 Curtis Lane, Naperville, Illinois 60540, who will also be happy to answer questions on its construction.

My sincere thanks to WØLER and W3GEY for their able assistance in testing this converter.



L1, 3, 4, 5, 7= #16 wire spaced 4mm above ground plane.
L2, 6= #18 same spacing as above.
L8= 16t #28 on .250" form (slug tuned).
L9= 6t #28 on .250" form (slug tuned). See Y1 note.
L10= 2t #16, .250" ID, spaced 1t.
Q1, 2, 3= Motorola MPS-H83 or equivalent.
Q4, 5= 2N918 or equivalent.
Y1= 67.333 MHz (then L9 is 6t) for 432 MHz. 67.833 MHz for 435 MHz.
Y1= 101.00 MHz (then L9 is 4t) for 432 MHz. 101.750 MHz for 435 MHz.
Note: Germanium (Ge) diodes may be 1N82 or equiv.
Note: Tune L9 for 67.333 MHz (or 101.00 MHz), L10 for 202 MHz, and L7 for 404 MHz.
Note: Taps on tuned lines may be set between 6 and 8 mm from grounded end of line initially. Optimize position for best NF.
Note: .68 uh chokes are 20t of #28 on 150k ½W resistor
F= 3 ferrite beads slipped over base end of 4.7k resistors in the RF stages.

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"DONT KNOCK IT UNLESS YOU'VE TRIED IT!"

by Bud Schultz, W6CG

After some 48 years of hamming I've just about made the full route. The DX craze with its pile-ups -- the message handling bit and the BPL -- 15 years of pioneering RTTY and trying to make 100 countries on FSK -- etc., you name it and I've tried it! Field days - VHF contests - hidden transmitters - QRP rigs. From the oatmeal box helix and slop jar rectifiers to the modern S line gear is a long trip but I rode it all the way. Then one day an old pal of some 40 years standing said "hey - how about listening for me on OSCAR 6?" Not being an Astro-physicist I sure wasn't very keen about the idea but not knowing how to brush off an old pal, I agreed to give it a try. He suggested all I had to do was listen around 29.5 MHz at the right time and that was all there was to it. I gave it a try and was amazed to hear some 30 CW and SSB signals coming off a really dead ten meter band; from Maine to Hawaii and Florida to Alaska. As a matter of fact I optimistically rigged up my CL-146 (10 watts?) so I could key the PTT and impatiently waited for the next pass of that derned "shoebox" in the sky. I didn't expect too much from my "Ringo" vertical but when I heard things start to happen I put out a CQ and to my wonderment here comes KL7MF calling W6CG and asking for a report on his sigs! Honestly - fellers - for the first time since my first ham QSO some 48 years ago, I got buck fever. Couldn't hardly remember my own call and my hands were sweating like a novice on his first time out!

All of the above is just my way of saying if you are finding Ham Radio a bit dull at times or if you are becoming a bit bored with your hobby, give OSCAR and the AMSAT group a try. At the very least, you will find it a challenge and if it doesn't raise your blood pressure the first time you get an answer back to your first call into space, then you are a medical phenomena. It really doesn't require any fancy gear but like every other facet of Ham Radio - the better the gear, the better the results. I'm still using the Ringo vertical but have upped the power to a big fat 80 watts and I must say I did just about as well with the little FM rig I started with. The log shows 27 states and 3 countries worked so far since the first of December. I still look forward to every pass of the thing in the hope of getting something new. If you want to try your hand at this and want some info to help you get under way, just send a large SASE with 20 cents postage to ARRL and request their guide to amateur satellites.

Just keep in mind that in the next few years much of our communications will be via satellites, and you should be glad of a chance to get in on the ground floor. OSCAR 7, which will be launched shortly, will include 432 to 144 translators as well as 146 to 29 MHz links. This satellite hopefully will be available along with OSCAR 6, so activity should be plentiful.

Again, I repeat - you don't have to be a space scientist to become involved in this most interesting phase of Ham Radio. "Try it - you'll like it!"

WASHINGTON SATELLITE AWARD

Here is information on the new Washington Satellite Award.

1. The Washington Satellite Award is available to any licensed amateur.

2. Washington stations must contact, on any mode via an amateur satellite.

3. Only contacts after March 1, 1974, will qualify for the award.

4. All U.S.A. and Canadian call areas must contact five Washington stations via amateur satellite.

5. DX stations must only contact three Washington stations via amateur satellite.

6. All QSL's must indicate a date of March 1, 1974, or later.

7. Cost: $1.00. This is to be submitted with award request. This will cover the cost of the award, handling and registered mail return of the QSL's and award.

8. Award requests must be submitted to:

Tim Blair, WA7FVT
431 Broadway, Apt. 610
Tacoma, Washington 98402

This award has been established for the purpose of promoting two-way communications with Washington amateurs through the AMSAT programs via satellites.

LETTERS

Dear Sir:

Many thanks for the nice things you said in your article, "OSCAR Nostalgia," in March AMSAT Newsletter -- really appreciated the look back!

Want to correct two errors -- there were 7 QSO's on OSCAR IV. W3ASK's Space Column, April 1966 CQ, page 87, listed the last QSO through that little baby -- W6UK with K1LSY/6. That QSO was on Orbit #96, Jan. 29, 1966 at 1507 GMT, CW, 559 both ways. We had tried the weekend before but although we heard each other, the thing acted up at wrong times, so that we couldn't get signal reports through. The weekend we did -- we had a landline through -- we were both in Camarillo, Calif -- so we could say -- "I gotcha, gimme signal report" -- we were besides using FSK to hold O-4 latched in. Later at Fresno VHF Conference one of the fellows from Pasadena (W6PUZ?) said he heard our two-way and tried to QSO us but no dice. We quit calling each other and both called W4WNH like mad when he came in with 57/89 sig -- but Shelby never heard us! It was a wild one -- sure hope they go for a Geosynchronous orbit.

Bill Hunter, K4TI
Weaverville, N.C.
March 5, 1974

Dear Sir:

In the December issue of the AMSAT Newsletter you show an activity list and quote for Japan, 90 OSCAR users as being 0.67% of a total of 14,576 amateurs.

Where on earth did you get the last figure which is so grossly in error? Possibly from the International Callbook which is absolutely inaccurate in the case of Japan since it lists only those few Japanese stations who have informed them of their addresses in English.

According to my information in March 1974 the number of Japanese amateur station licenses now issued is:

436,377 !!!

They do have a large 2m amateur population but probably over 95-98% of these only on 2m FM.

OSCAR 7 is going to be busy when the Japanese ham stations change to SSB!!

James C. Pershouse, 9M2DQ
Penang Island, Malaysia
March 28, 1974

Dear Sir:

I must register my support of the 15-10 linear repeater proposal. Such a repeater would not run contrary to Objective E, although it may not directly support it (but who is to define "higher frequency?"). The other objectives of AMSAT would be supported by such a repeater, especially in bringing about worldwide use on a large scale.

With proper choice of passband frequencies and times of operation, I cannot visualize any problem with unintended use, and the research possibilities are nothing short of exciting! Wouldn't this be the first HF-HF orbiting repeater? Now there's some real pioneering! And all at a time when 10 and 15 are at a real low point of activity. Don't kill a great idea just because it doesn't fit in letter perfect with past activities and goals of AMSAT.

I have a fear that those who object to the idea fear bringing satellite use to the "common ham"!!

Bruce Frahm, WAØTAS
Colby, Kansas
April 10, 1974

Dear Sir:

I recently received a most interesting letter from K4TI in which Bill mentioned that my recent article, "OSCAR Nostalgia," omitted mention of the seventh and last QSO recorded via OSCAR 4 -- between W6YK and K1LSY/6 during Orbit 96 on January 29, 1966. Both stations were located in Camarillo, California.

In addition, further investigation has revealed that my earlier article on "Satellite Operating Awards" (June 1973 issue, page 8) contained a minor error with respect to the CQ DX Award Satellite Endorsement, which I would now like to correct. As many readers know, CQ Magazine issues the CQ DX Award for working and confirming 100 countries or more either on CW or on SSB -- a sort of single-mode DXCC. Once one has the basic award, various endorsements are available. One of these, which incidentally has yet to be awarded, is given for working 50 countries via amateur satellite, with each two-way QSO using the same mode as the basic award. For example, I happen to have CQ CW Award No. 7; were I to apply for the satellite endorsement, I would have to present 50 QSL cards, each showing two-way QSO with a different DXCC country on CW and using an amateur satellite. My article had failed to mention the mode requirement. All contacts submitted need not have been using the same satellite; OSCARS 3, 4, 6 and 7 are all OK. In my humble opinion, this is the toughest satellite award yet offered.

Ray Soifer, K2QBW
Glen Rock, New Jersey
April 22, 1974

AMSAT GRATEFULLY ACKNOWLEDGES DONATIONS OF $50.00 OR MORE FROM THE FOLLOWING WHO HAVE RECENTLY APPLIED FOR LIFE MEMBERSHIP

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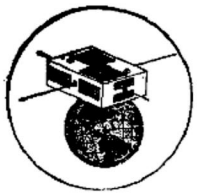

GETTING STARTED IN SATELLITE COMMUNICATIONS:

How and When to Work Through OSCAR 6 & OSCAR 7

by Raphael Scifer, K2QBW[1]

With the launch of OSCAR 6 on October 15, 1972, amateur satellite communications became readily available and practicable for large numbers of radio amateurs around the world. Over 2,000 are already participating in this newest phase of amateur radio, and several hundred more are joining in each month. OSCAR 7, expected to be launched later this year, should be even more accessible. This article presents the essentials of getting started: equipment requirements, frequencies, and perhaps most important, how to track OSCAR and where to obtain orbital information so as to know when and where to look.

OSCAR 6 is a linear translator, functioning very much like a receiving converter. It listens over the band 145.900 to 146.000 MHz, and down-converts to 29.450 to 29.550 MHz. Within this band, what you put in on two meters is what you hear on ten meters; if you transmit CW, you hear CW; if you transmit upper sideband, you hear upper sideband. Because of OSCAR's altitude, you will have a maximum two-way communication range of approximately 5,000 miles when properly positioned -- not bad for a low-power ground station on two meters! Although most OSCAR users have small beams, OSCAR has been worked successfully from mobile stations in automobiles, aircraft, even a sailboat!

OSCAR 7 works the same way, except that it has two translators aboard, one for two-to-ten meters, the other 432 MHz in, 145 MHz out. Table 1 gives specific frequencies for OSCAR 6 and OSCAR 7 operation. With OSCAR 6, if you transmit on 145.950 MHz (neglecting Doppler), you should hear yourself through the satellite on approximately 29.500 MHz (actually around 29.494 MHz, since OSCAR 6's crystals are 6 kHz low); if you transmit 20 kHz lower, you'll hear yourself 20 kHz lower on ten meters. OSCAR 7's two-meter input and ten-meter output work in exactly the same way as OSCAR 6, except that each is 50 kHz lower in frequency (see Table 1). The 432 MHz translator aboard OSCAR 7 is a little different, since it employs frequency inversion; if you transmit lower sideband, you'll get upper sideband back!

In this article, we'll be using the term OSCAR to mean OSCAR 6 or OSCAR 7 interchangeably; where there is a difference, the text will make the necessary distinctions.

OSCAR's transmitter power is quite low, and must be shared among all the stations using the satellite at any one time. To work through the satellite successfully, you have to be able to hear it well; beyond any doubt, the greatest single cause of failure in OSCAR communication is inadequate receiving capability. During any OSCAR orbit, a number of stations can be heard calling CQ, often quite loudly, completely unaware of other stations calling them. If they took a little trouble to improve their receivers, everyone would benefit! Actually, a good receiver for OSCAR is quite simple to arrange. On two meters, any good low-noise converter, with proper front-end alignment, should suffice. Check yours with a

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Table 1: OSCAR 6 and OSCAR 7 Input, Output and Beacon Frequencies

	Input (Uplink)	Output (Downlink)	Beacon (Telemetry)
OSCAR 6	145.900-146.000	29.450-29.550	29.450
			435.100 (silent)
OSCAR 7	145.850-145.950	29.400-29.500	29.500
	432.125-432.175	145.975-145.925 (inverted)	145.980
			435.100
			2304.100

OSCAR 6 output frequency is 116.456 MHz lower than its input frequency, within the above bands. For OSCAR 7, its ten-meter output is 116.450 MHz lower than its two-meter input, and its two-meter output frequency (for 432 MHz input) is given by

$$F_{out} = 578.1 - F_{in} \text{ (MHz)}.$$

These output frequencies must also be corrected for Doppler shift of up to plus/minus 5.7 kHz (your own signal) or plus/minus 11.3 kHz (other signals) for two-meter output.

noise generator or other test equipment to be sure it is giving you its rated performance. On ten meters, experience has shown that many receivers, even the most expensive, can benefit from a simple low-noise MOSFET preamplifier, adjusted for the OSCAR output band, such as the one listed in the bibliography. If you're not using a good preamp, you might also gain satisfactory performance by realigning your receiver's ten-meter circuits for optimum performance at 29.5 MHz. Many amateur-band receivers, such as the Collins S-line, come from the factory set up for peak performance at 28.5-28.7 MHz; their sensitivity at 29.5 MHz is often terrible. A few twitches with an alignment tool, and the OSCAR-band sensitivity becomes quite satisfactory, at some cost, however, to the low end of the band. OSCAR is more fun than 10 meters, anyhow!

Spend some time listening to the satellite. Most any old clunker of a receiver can hear a few of the strongest stations, but this is not good enough. You should hear both sides of each QSO. When the satellite comes within range, your received noise level should noticeably increase, because you will be hearing the retransmitted noise in the satellite's receiver! The beacons listed in Table 1 are another good guide; you should hear the ten-meter beacon of OSCAR 6 or OSCAR 7, and the two-meter beacon of OSCAR 7, clearly whenever the respective repeater output is audible. These beacons are actually quite important, since they transmit telemetry information on how the satellite is doing. Most of the time, they will be transmitting 3-digit numbers in conventional CW, interspersed with OSCAR's traditional "HI HI" identification. Occasionally, the OSCAR 7 beacon may also transmit RTTY. By all means, copy the telemetry information down and send it along to AMSAT as received. No further data reduction is necessary on your part; AMSAT will do the rest, and you'll be helping to keep the satellite going for as long as possible. Please include the date and time of receipt, and the orbit number if you know it (see below).

After you attain satisfactory reception -- an official OSCAR QSL card is sent for all reception reports -- you're ready for the next step: reception of your own signal, retransmitted through the satellite. OSCAR is designed for CW and SSB transmissions; although the satellite, as a linear translator, will also repeat AM and FM, they are highly inefficient uses of the satellite's shared power because of their relatively high average powers. Also the AM or FM station is not too likely to gain an answer, since everyone's receiver is set up for narrow-band CW or SSB.

To work through the two-to-ten meter translator, an effective radiated power (ERP) -- transmitter output minus transmission line losses plus antenna gain -- of approximately 100 watts is required. Under ideal conditions, it's been done with as little as 10 watts ERP, but 100 watts ERP is the recommended level. The 432 MHz translator requires approximately 400 watts ERP at that frequency. If you need more than this to hear yourself, that is proof positive that your receiving system needs more work! As an example of this calculation, a transmitter having 50 watts output into a transmission line having 3 dB loss, and an antenna having 6 dB gain would give you 100 watts ERP, the correct level at 145 MHz.[2]

A stable, well-calibrated VFO or VXO is a great convenience, since most OSCAR users answer calls at or near the caller's frequency -- the better to hear their own signals while working. If you don't yet have one, don't let that stop you; procure a crystal for one of the input ranges in Table 1, and listen for your signal at the output frequency derived from the relationships given in the same table. Bear in mind that these output frequencies are approximate, and will change during each orbit because of the Doppler effect. Tune around a bit, within the Doppler tolerances given in Table 1; you'll soon catch on to the way Doppler works.

With the two-to-ten meter repeater, your signal will come back higher in frequency than it is "supposed to" if the satellite is moving toward you, lower in frequency than nominal if the satellite is moving away from you. The OSCAR 7 432-to-145 MHz repeater, because it employs frequency inversion, will give exactly the opposite effect. With this repeater, your signal will come back at lower than nominal frequency with the satellite moving toward you, and higher with the satellite moving away from you. Doppler effects of signals other than your own will be somewhat more complex to predict, because two relative velocities are involved in each case. In no case, however, will the received frequency be further away from nominal than the Doppler tolerances given in Table 1.

For receiving purposes, most stations use 10-meter beams. As with receivers, however, trap tribanders and similar arrays can be misleading, since they are commonly adjusted for best results at the low end of the band and are frequently disappointing at the OSCAR frequency unless re-tuned. The usual monobander is broad enough to be satisfactory; check and see. Quite satisfactory results have been obtained with less than a beam; W2GN uses a mobile whip for his automobile "DXpeditions" via OSCAR, and many stations use dipoles and other wire arrays. For best results at low elevation angles, however, when the real DX is worked, a beam simply cannot be beat!

For the VHF and UHF frequencies, experience has shown that beams of four to eleven elements (9 dB to 14 dB gain) give the best results. Larger arrays, being more directional, are more difficult to keep properly aimed at the moving

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[2]Actually, if you use much more than the recommended ERP levels, you may well overload the satellite's translator, causing other signals to be reduced in strength and quite possibly disrupting other contacts in progress. Because of this, FCC has interpreted overloading the satellite as a violation of section 97.67(b) of the Rules. AMSAT urges all OSCAR users to monitor their own signals through the satellite, and to cut down their power if their signal strength is excessive.

satellite than beams of eleven or fewer elements. Again, if you cannot put up a beam, you still can work through OSCAR if your transmitter puts out enough power; the author once worked 35 stations with 40 watts and a window whip, and 50 more with a "Squalo." K2QBW presently uses a four-element Yagi on two and a two-element Yagi on ten.

In reading through the literature on OSCAR, you will constantly come across references to circular polarization and azimuth-elevation rotators. In this writer's considerable experience with OSCAR, both are desirable but not necessary features. Without circular polarization on two meters with OSCAR 6, your signal will encounter fading due to Faraday rotation; the OSCAR 7 receiving antennas are designed to make this unnecessary. Circular polarization at ten meters is for most amateurs easier said than done, because of ground reflection effects. If you can put up a cross-Yagi or helical array, by all means try it, but don't think you really need one. With linearly polarized antennas, your signal will fade up and down as your polarization is rotated in the ionosphere. You may use either vertical or horizontal polarization; it makes no difference. If you do use a beam antenna and do not have azimuth-elevation rotators, it is recommended that you mount the beam to point upward approximately 20 to 30 degrees from the horizon, and leave it there, rotating it in the horizontal plane as needed. With a beam pointing toward the horizon, you may encounter difficulty in working OSCAR passes of higher elevation; 20 to 30 degrees fixed elevation has been found by many users to be an excellent compromise, making further attention to elevation unnecessary.

Now that you've set up your antennas, the next step is to figure out where to point them, and when to listen. This is really much easier than many people think, and actually is one of the most interesting and educational facets of satellite communications.

The orbit of OSCAR 6 is almost identical to that of OSCAR 5 and to the one planned for OSCAR 7 -- close enough so that the same tracking system may be used for each. Accordingly, although this article was written with OSCAR 6 in mind, it should work just as well for OSCAR 7. Each satellite orbits the earth in an almost perfect circle; the satellite's altitude above the earth's surface is approximately 910 statute miles at all points. From this height, OSCAR can "see" 2450 miles in all directions along the earth's surface. Therefore, if your station is within 2450 miles of the point on the earth's surface at which OSCAR is directly overhead (called the sub-satellite point or SSP), you should be able to hear OSCAR's signals and to work through it yourself. As OSCAR moves along in its orbit, the sub-satellite point naturally moves along with it, like a shadow. Some stations will come into range, others drop out. If you know the location of the sub-satellite point, you know which stations will be within range, and which will not. Because OSCAR's orbit is extremely regular, keeping track of the sub-satellite point is rather easy, once you've mastered a few basic facts about satellite orbits in general and OSCAR in particular.

A satellite's orbit is expressed in terms of its altitude and its inclination; if you know these two things, you can figure out just about everything else. OSCAR's altitude we already know, 910 miles at all points. The inclination refers to the angle at which the satellite's orbit intersects the earth's equator. Since OSCAR intersects the equator twice during each orbit -- once going north, once going south -- the northbound crossing, or ascending node, is used as the reference point. Whenever OSCAR crosses the equator going north, it does so at the angle shown in Figure 1. OSCAR's inclination angle, then, is 101.77 degrees. Since its inclination is greater than 90 degrees, OSCAR's orbit is commonly spoken of as a retrograde orbit, i.e., one which moves in a westerly direction as the earth turns from west to east. This fact, namely that the earth is rotating from west to east as the satellite orbits, means that the sub-satellite point does not move in a straight line along the earth's surface; it is always curving to the west as the earth rotates under the orbiting spacecraft.

Because we know OSCAR's altitude, Newton's and Kepler's laws allow us to compute its orbital period, the time interval between successive northbound equatorial crossings. For OSCAR, this is 114.99455 minutes. Every 114.99455 minutes, the earth rotates eastward on its axis exactly 28.7487 degrees.

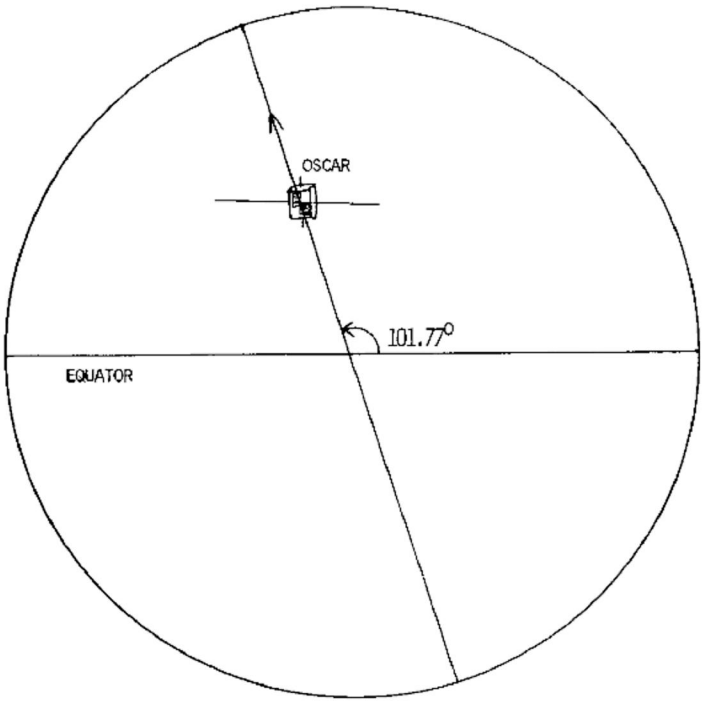

Figure 1: OSCAR's orbital inclination is 101.77 degrees.

Let's stop and think what this means. If we know, for example, that on January 1, 1974, at 0024.5 GMT (0024 and 30 seconds), OSCAR 6 crossed the equator going north at 53.8 degrees west longitude, then the figures quoted above allow us to compute OSCAR's next equatorial crossing as well. How? Well, it will be 114.99455 minutes later and 28.7487 degrees further west, or 0219.5 GMT and 82.5 degrees west longitude. In fact, because of the regularity and stability of OSCAR's orbit, we may keep adding 114.99455 minutes and 28.7487 degrees to each equatorial crossing, and thus predict the next one, for months and even years in advance. Got your adding machine ready?

OSCAR equatorial crossings are published in the AMSAT Newsletter, sent quarterly to all AMSAT members.[3] They are also published frequently in QST, CQ and many national amateur journals around the world. They are broadcast over

[3]OSCAR is an open repeater, maintained by AMSAT control stations for the use of all radio amateurs throughout the world. Membership in AMSAT is also open to all; for information, write AMSAT, P. O. Box 27, Washington, D. C. 20044. Individual membership dues are $5 per year, including a subscription to the AMSAT Newsletter. AMSAT is a nonprofit, scientific corporation; membership dues go for membership services and to support the construction of future amateur satellites.

W1AW and GB2RS; see recent issues of QST and Radio Communication for the current bulletin schedules. AMSAT supplies the orbital information for all of these media, in a form which is compatible with the terms used in this article. All published and broadcast OSCAR material gives, for each orbit, the orbit number, a convenient reference which started with the satellite's first orbit, the date in GMT and the time in GMT of northbound crossing, and the longitude at which that equatorial crossing is to take place. For convenience, longitudes east of Greenwich are converted into west longitude; a crossing at 10 degrees east longitude would be given as 350 degrees west, the following crossing would be at 18.7 degrees west. To save space, most publications give only one orbital crossing per day. This is no real problem for the user, since he can generate the missing orbits himself simply by adding 114.99455 minutes and 28.7487 degrees successively. For one day's orbits, these may be rounded off to 115 minutes and 28.75 degrees. If you miss a week's data, or a month's, again no problem -- just keep adding! Remember to change the date as you go past 2400 GMT, and to subtract 360 degrees if you come up with, say, 378.7 degrees west longitude.

Now that we know the time and longitude of equatorial crossing, we can get on with the business of determining when and where to look for OSCAR. To reiterate, OSCAR is within communication range whenever its sub-satellite point is within 2450 miles of your station. So, the first order of business is to procure a good map showing longitudes and latitudes, mark the exact location of your station, and draw a circle around your station of 2450 miles radius. This last item may be tricky, since most maps contain a good deal of distortion caused by the difficulty of projecting a spherical earth onto a plane surface. If you are lucky enough to have a great-circle map with your own location at the center, you're all set. If not, you may wish to take a measuring tape or string and, using a good globe, mark off a series of points in all directions, each 2450 miles from your location on a great-circle path, then transfer these points to your flat map. Don't be surprised if you don't get a circle; most people won't. For each such point which you transfer, remember the direction on the globe; this will become the beam heading which you will use when OSCAR crosses that point.

OK, now you have a map showing a series of points in all directions, each point being 2450 great-circle miles from your QTH. If you connect these points, the area inside the resulting curve is your OSCAR coverage area. The information which we need to connect the equatorial crossing data with your OSCAR coverage map is given in Table 2.

If you will recall, we said earlier that OSCAR crosses the equator with an inclination angle of 101.77 degrees, and that during each orbit, the earth rotates eastward on its axis 28.7487 degrees. Table 2 takes both of these facts into account and, for any equatorial crossing, will tell you the time, latitude and longitude of the sub-satellite point throughout the orbit. By plotting this information onto your map, or onto a transparent or translucent overlay, you can see easily whether that particular orbit is at all within range, and if so, when to listen and where to point your beam. The equatorial crossing, again, is defined as the time and longitude at which OSCAR crosses the equator going from south to north (ascending node). This point is shown in the extreme upper left of Table 2; to find the time at which the sub-satellite point crosses zero degrees north latitude, going from south to north (SN 0), add zero minutes to the equatorial crossing time. So far, so good. At 3.23 minutes after equatorial crossing, the SSP crosses 10 degrees north latitude (SN 10); at that point, its longitude is 2.89 degrees west of the equatorial crossing point. As may be seen, the sub-satellite point continues to move north and west until it reaches its northernmost point (approximately 79 degrees north latitude), some 28.69 minutes after and 96.98 degrees west of its equatorial crossing. At that point, the sub-satellite point continues to move westward -- it is always moving westward -- but its path begins to turn south and the orbital movement is now from north to south. It again crosses 10 degrees north latitude, but this time going from north to south (NS 10), at 54.17 minutes after equatorial crossing and 191.44 degrees west of its equatorial crossing longitude -- more than halfway around the world!

SSP Latitude North	Time Add Minutes	Longitude Add Degrees	SSP Latitude South	Time Add Minutes	Longitude Add Degrees
SN 0	.00	.00	NS 0	57.41	194.33
SN 10	3.23	2.89	NS 10	60.65	197.23
SN 20	6.47	5.92	NS 20	63.91	200.26
SN 30	9.73	9.27	NS 30	67.17	203.61
SN 40	13.02	13.22	NS 40	70.47	207.55
SN 50	16.35	18.31	NS 50	73.81	212.64
SN 60	19.77	25.86	NS 60	77.24	220.17
SN 70	23.44	40.35	NS 70	80.92	234.59
SN 75	25.64	56.67	NS 75	83.13	250.81
Northernmost point	28.69	96.98	Southernmost point	86.19	290.98
NS 75	31.74	137.44	SN 75	89.25	331.58
NS 70	33.94	153.86	SN 70	91.45	348.10
NS 60	37.62	168.41	SN 60	95.14	2.73
NS 50	41.04	175.99	SN 50	98.56	10.33
NS 40	44.37	181.09	SN 40	101.90	15.45
NS 30	47.66	185.05	SN 30	105.19	19.41
NS 20	50.92	188.40	SN 20	108.45	22.77
NS 10	54.17	191.44	SN 10	111.70	25.80
NS 0	57.41	194.33	SN 0	114.99	28.74

Table 2: OSCAR 6 orbital path corrections from equatorial crossing. From this chart, and the equatorial crossing data given in the text, the position of the sub-satellite point at any time during the orbit may be easily determined. These values should also be good for OSCAR 7.

Source: AMSAT Newsletter, Vol. V, March 1973.

During its orbit, the sub-satellite point crosses the equator a second time, going from north to south (NS 0), 57.41 minutes after and 194.33 degrees west of its northbound equatorial crossing. This southbound crossing is called the descending node and is not the equatorial crossing referred to in OSCAR orbital predictions; the "official" crossing is always the one moving from south to north. From the descending node, the sub-satellite point continues south and west until it reaches its southernmost point, then moves north and west until another northbound equatorial crossing occurs, 114.99 minutes after and 28.74 degrees west of the first one.

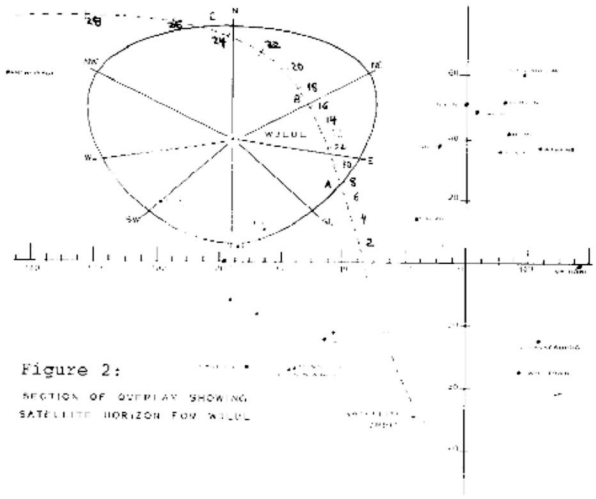

Figure 2:
SECTION OF OVERLAY SHOWING
SATELLITE HORIZON FOR W3LUL

Source: AMSAT Newsletter (W3LUL), Vol. IV, September 1972.

Let's look at a practical example. W3LUL is located at 39 degrees north, 77 degrees west; Carl's OSCAR coverage map is shown in Figure 2. Using the data in Table 2, Carl plotted the location of the sub-satellite point for an orbit having an equatorial crossing at 33 degrees west longitude; the figures along the dashed line refer to the time in minutes after equatorial crossing. Using this example, W3LUL would have acquisition of signal (AOS) approximately 8 minutes after equatorial crossing at a beam heading of approximately 110 degrees, and would have loss of signal (LOS) approximately 25 minutes after equatorial crossing at a beam heading of around 345 degrees.

Different amateurs, of course, have different systems, depending upon their needs and inclinations. The author, for instance, started out with W3LUL's system described above, then found that sufficient accuracy for his relatively small antennas could be had by plotting beam headings (using map and overlay as above) for various equatorial crossings at 10-degree intervals, then summarizing the resulting information in tabular form as shown in Table 3. K2QBW is located at 41 degrees north, 74 degrees west. Using this table, or one like it for your location, all that is necessary to work the satellite is the orbital crossing information; no further plots are needed once the basic work has been done.

Because OSCAR is at an altitude of 910 miles, its angle of elevation, as seen by your antennas, varies considerably depending on the location of the sub-satellite point. Figure 3 gives this information.

Now that we have computed when and where to look for OSCAR once we know the time and longitude of equatorial crossing, and have discussed where to obtain (or, if need be, to generate our own) equatorial crossing information, we should be all set. Right?

Table 3: K2QBW Beam Headings -- Minutes from Ascending Node

Ascending Nodes -- Easterly

Longitude of Ascending Node	S	SE	E	NE	N	NW
0				24	27	
10			15	20	26	
20			11	18	25	
30		8	12	17	24	27
40		6	12	16	22	26
50		4	10	15	18	25
60		3	12	13	14	22

Ascending Nodes -- Westerly

	2	11	[illegible]	[illegible]	
70	2	11	[illegible]	[illegible]	
80	2	9	[illegible]	[illegible]	
90	4	7	[illegible]	[illegible]	
100		6	12	18	
110			11		

Descending Nodes -- Easterly

	NE	E	SE	S
210	41	46	52	
220	37	46	50	
230	35	45	48	56
240	34	44	46	50
250	34	43	44	45

Descending Nodes -- Westerly

	NE	N	NW	W	SW
260	33	39	43	45	50
270	32	36	42	46	52
280		32	41	46	
290		32	40	47	
300		31	38	44	

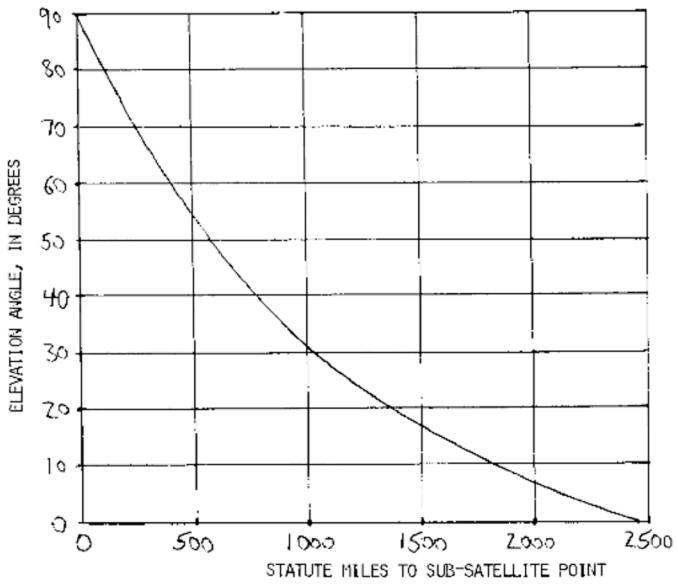

Figure 3: OSCAR elevation angles.

Source: Recalculated by the author from AMSAT Newsletter (WØPHD), Vol. V, June 1973.

Unfortunately, it seems that OSCAR 6, like many electronics systems powered by nickel-cadmium batteries, cannot be turned on 24 hours a day, seven days a week, and still function properly for any length of time. It must have periodic times when it is turned off, so the solar cells have a chance to recharge the nickel-cadmium battery. So, quite frequently, when OSCAR is within communication range, it will be silent. In parts of the world served by active AMSAT control stations, these times off are scheduled and publicized through the AMSAT Newsletter, W1AW, on-the-air AMSAT nets (see the Newsletter for current information), and often on the satellite itself by AMSAT Bulletin Stations. In other parts of the world, OSCAR 6 turns itself on and off through transients in its experiment control logic. Hopefully, OSCAR 7 will not experience this transient problem, and its operating schedule will be more regular and less subject to change than OSCAR 6.

Because OSCAR 7 has been designed for a positive power budget, it is hoped that scheduled recharge days will not be necessary. Present plans call for OSCAR 7's operation to be switched between repeaters every 24 hours. Thus, the two-to-ten meter unit will be operational one day, the 432-to-145 MHz unit the next day, then back to two-to-ten, etc. Each repeater will be turned off when not scheduled for use.

In any event, if orbital calculations show that you should be hearing OSCAR, and you do not, by all means don't give up. Try different orbits; you're sure to find some in which the satellite is turned on, and the above sources will have up-to-date information. Along this same line, you may encounter orbits in which the beacon is heard, but few if any stations. Generally, these will be so-called "reference" orbits, or the first equatorial crossing of each GMT "off" day. The purpose of these orbits is to enable telemetry readings to be transmitted via the Morse code telemetry feature of the ten-meter beacon. If you encounter such an orbit, please do not transmit to the satellite; instead, listen and see if you can copy the beacon, and report the telemetry received to AMSAT.

AMSAT, ARRL and other groups sponsor numerous interesting on-the-air activities involving OSCAR, in which your participation is cordially invited. Among these are weekly AMSAT nets on 75, 20 and 15 meters, contests such as Field Day and the ARRL 10-meter event in which OSCAR contacts count, operating awards such as the Satellite Communicators Club, Satellite DX Achievement Award, WVE Satellite Award, Hawaiian Award, even awards for working all states via OSCAR and for working 50 countries -- at this writing, all but the latter have been won numerous times. Information on all of these is available from AMSAT. All of us in AMSAT and using the satellite hope to hear from you and to work you soon.

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AMSAT-OSCAR 6 REFERENCE ORBITS AND OPERATING SCHEDULE

Currently, the AMSAT-OSCAR 6 two-to-ten meter repeater is ON for communications during south-to-north (local evening ascending node) passes on Mondays, Thursdays and Saturdays (GMT days), and for experiments and educational demonstrations on Tuesday and Friday north-to-south (local morning descending node) passes.

The updated reference orbit data given below for AMSAT-OSCAR 6 are supplied by AMSAT. Times are in GMT, and Longitudes are in degrees west of Greenwich. A more complete printout of all the orbits for a 1 to 2-month period is available from AMSAT, P. O. Box 27, Washington, D.C. 20044 USA, in return for your report of communications use of OSCAR 6.

Period = 114.99455 minutes. Longitude increment = 28.7487 degrees per orbit.

Note that orbits repeat on a 263-orbit cycle every three weeks (i.e., each 21 days), but 3.6 minutes later and 0.9 degrees further west.

REV	DATE	TIME Z	LONG W
7430	JUNE 1	0039.2	58.1
7443	JUNE 2	0134.1	71.8
7455	JUNE 3	0034.1	56.8
7468	JUNE 4	0129.0	70.5
7480	JUNE 5	0028.9	55.5
7493	JUNE 6	0123.9	69.2
7505	JUNE 7	0023.8	54.2
7518	JUNE 8	0118.7	67.9
7530	JUNE 9	0018.7	52.9
7543	JUNE 10	0113.6	66.7
7555	JUNE 11	0013.5	51.6
7568	JUNE 12	0108.5	65.4
7580	JUNE 13	0008.4	50.4
7593	JUNE 14	0103.3	64.1
7605	JUNE 15	0003.3	49.1
7618	JUNE 16	0058.2	62.8
7631	JUNE 17	0153.1	76.5
7643	JUNE 18	0053.1	61.5
7656	JUNE 19	0148.0	75.3
7668	JUNE 20	0047.9	60.2
7681	JUNE 21	0142.8	74.0
7693	JUNE 22	0042.8	59.0
7706	JUNE 23	0137.7	72.7
7718	JUNE 24	0037.6	57.7
7731	JUNE 25	0132.6	71.4
7743	JUNE 26	0032.5	56.4
7756	JUNE 27	0127.4	70.1
7768	JUNE 28	0027.4	55.1
7781	JUNE 29	0122.3	68.8
7793	JUNE 30	0022.2	53.8

REV	DATE	TIME Z	LONG W
7806	JULY 1	0117.2	67.6
7818	JULY 2	0017.1	52.6
7831	JULY 3	0112.0	66.3
7843	JULY 4	0012.0	51.3
7856	JULY 5	0106.9	65.0
7868	JULY 6	0006.8	50.0
7881	JULY 7	0101.8	63.7
7893	JULY 8	0001.7	48.7
7906	JULY 9	0056.6	62.4
7919	JULY 10	0151.6	76.2
7931	JULY 11	0051.5	61.2
7944	JULY 12	0146.4	74.9
7956	JULY 13	0046.3	59.9
7969	JULY 14	0141.3	73.6
7981	JULY 15	0041.2	58.6
7994	JULY 16	0136.1	72.3
8006	JULY 17	0036.1	57.3
8019	JULY 18	0131.0	71.0
8031	JULY 19	0030.9	56.0
8044	JULY 20	0125.9	69.8
8056	JULY 21	0025.8	54.7
8069	JULY 22	0120.7	68.5
8081	JULY 23	0020.7	53.5
8094	JULY 24	0115.6	67.2
8106	JULY 25	0015.5	52.2
8119	JULY 26	0110.5	65.9
8131	JULY 27	0010.4	50.9
8144	JULY 28	0105.3	64.6
8156	JULY 29	0005.3	49.6
8169	JULY 30	0100.2	63.3
8181	JULY 31	0000.1	48.3

REV	DATE	TIME Z	LONG W
8194	AUG 1	0055.1	62.1
8207	AUG 2	0150.0	75.8
8219	AUG 3	0049.9	60.8
8232	AUG 4	0144.8	74.5
8244	AUG 5	0044.8	59.5
8257	AUG 6	0139.7	73.2
8269	AUG 7	0039.6	58.2
8282	AUG 8	0134.6	71.9
8294	AUG 9	0034.5	56.9
8307	AUG 10	0129.4	70.7
8319	AUG 11	0029.4	55.6
8332	AUG 12	0124.3	69.4
8344	AUG 13	0024.2	54.4
8357	AUG 14	0119.2	68.1
8369	AUG 15	0019.1	53.1
8382	AUG 16	0114.0	66.8
8394	AUG 17	0014.0	51.8
8407	AUG 18	0108.9	65.6
8419	AUG 19	0008.8	50.5
8432	AUG 20	0103.8	64.3
8444	AUG 21	0003.7	49.2
8457	AUG 22	0058.6	63.0
8470	AUG 23	0153.5	76.7
8482	AUG 24	0053.5	61.7
8495	AUG 25	0148.4	75.4
8507	AUG 26	0048.3	60.4
8520	AUG 27	0143.3	74.1
8532	AUG 28	0043.2	59.1
8545	AUG 29	0138.1	72.9
8557	AUG 30	0038.1	57.8
8570	AUG 31	0133.0	71.6

REV	DATE	TIME Z	LONG W
8582	SEPT 1	0032.9	56.6
8595	SEPT 2	0127.9	70.3
8607	SEPT 3	0027.8	55.3
8620	SEPT 4	0122.7	69.0
8632	SEPT 5	0022.7	54.0
8645	SEPT 6	0117.6	67.7
8657	SEPT 7	0017.5	52.7
8670	SEPT 8	0112.5	66.4
8682	SEPT 9	0012.4	51.4
8695	SEPT 10	0107.3	65.2
8707	SEPT 11	0007.3	50.1
8720	SEPT 12	0102.2	63.9
8732	SEPT 13	0002.1	48.9
8745	SEPT 14	0057.0	62.6
8758	SEPT 15	0152.0	76.3

REV	DATE	TIME Z	LONG W
8770	SEPT 16	0051.9	61.3
8783	SEPT 17	0146.8	75.0
8795	SEPT 18	0046.8	60.0
8808	SEPT 19	0141.7	73.8
8820	SEPT 20	0041.6	58.7
8833	SEPT 21	0136.6	72.5
8845	SEPT 22	0036.5	57.5
8858	SEPT 23	0131.4	71.2
8870	SEPT 24	0031.4	56.2
8883	SEPT 25	0126.3	69.9
8895	SEPT 26	0026.2	54.9
8908	SEPT 27	0121.2	68.6
8920	SEPT 28	0021.1	53.6
8933	SEPT 29	0116.0	67.4
8945	SEPT 30	0016.0	52.3

REV	DATE	TIME Z	LONG W
8958	OCT 1	0110.9	66.1
8970	OCT 2	0010.8	51.1
8983	OCT 3	0105.8	64.8
8995	OCT 4	0005.7	49.8
9008	OCT 5	0100.6	63.5
9020	OCT 6	0000.5	48.5
9033	OCT 7	0055.5	62.2
9046	OCT 8	0150.4	76.0
9058	OCT 9	0050.3	60.9
9071	OCT 10	0145.3	74.7
9083	OCT 11	0045.2	59.7
9096	OCT 12	0140.1	73.4
9108	OCT 13	0040.1	58.4
9121	OCT 14	0135.0	72.1
9133	OCT 15	0034.9	57.1